Fig. 1

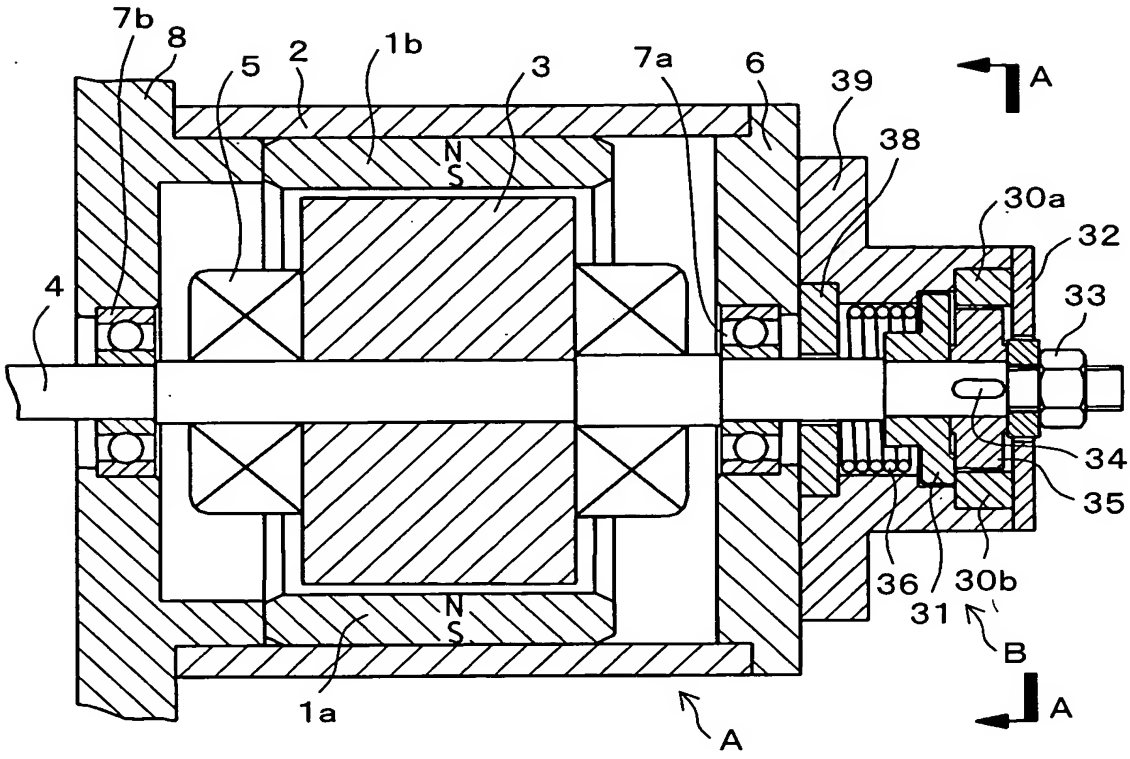

7b
8
5
2
1b
3
7a
6
39
A
38
30a
32
4
33
34
35
36
30b
31
B
A
1a
A
N
S
N
S

Fig. 2

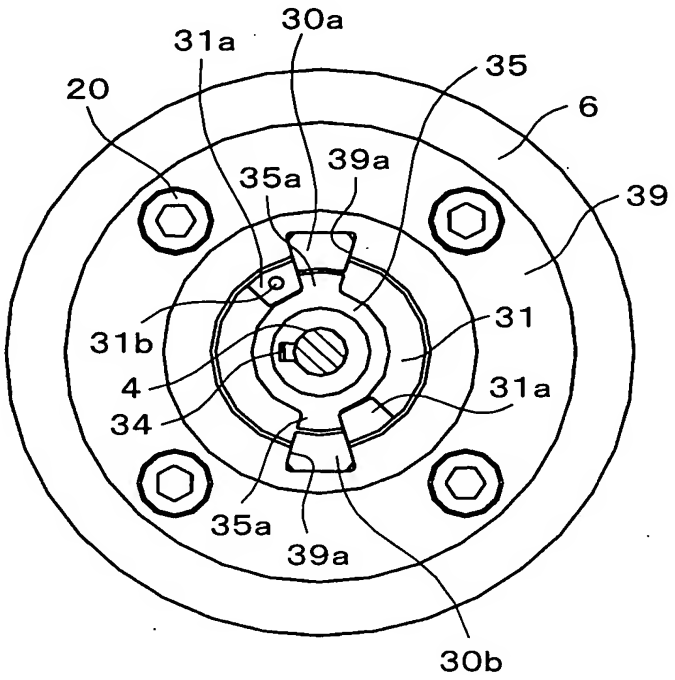

30a
31a
35
20
6
39a
35a
39
31
31b
4
31a
34
35a
39a
30b

Fig. 3

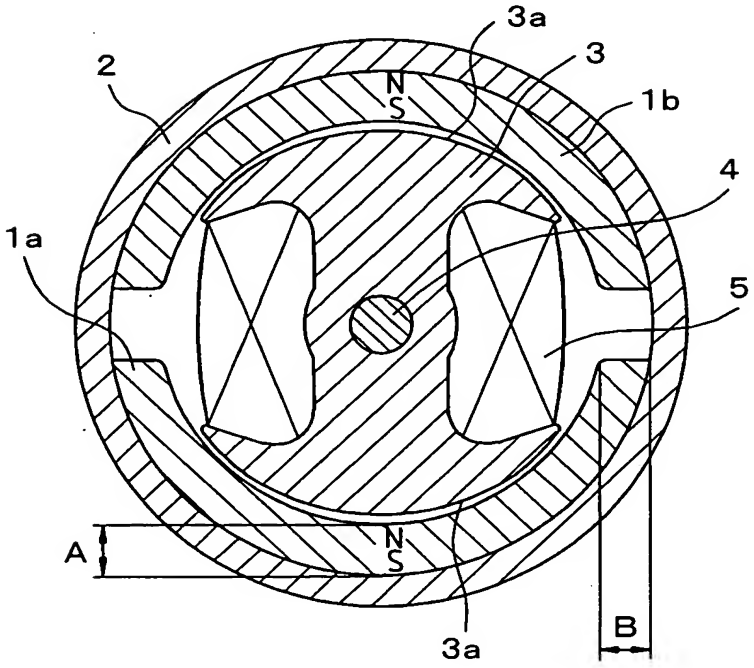


Fig. 4

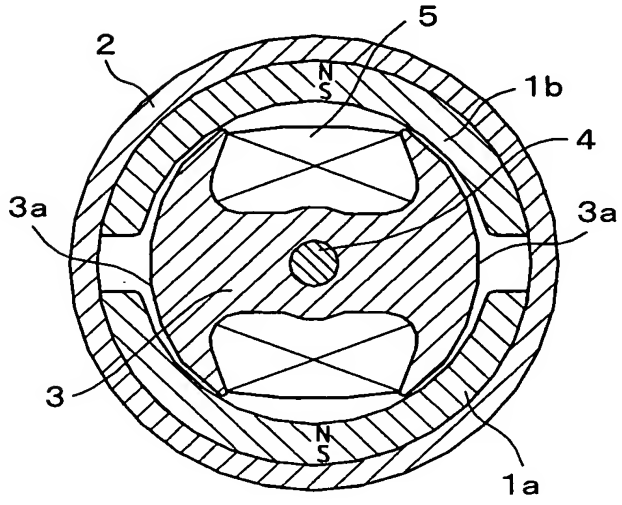


Fig. 5A

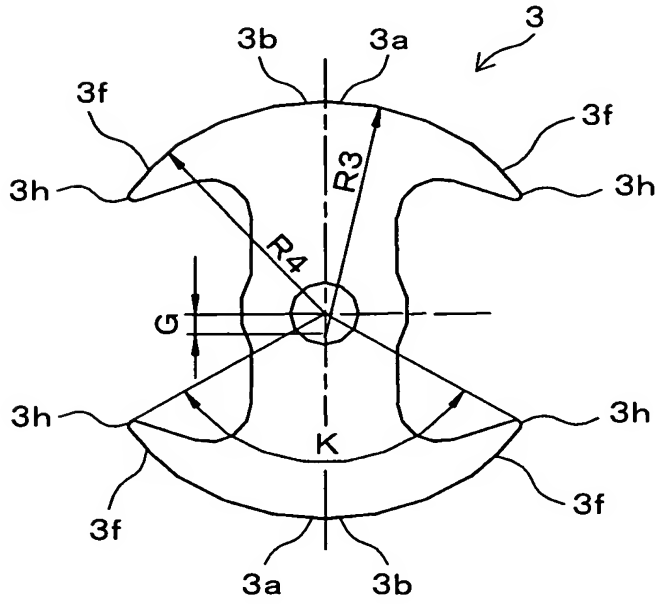


Fig. 5B

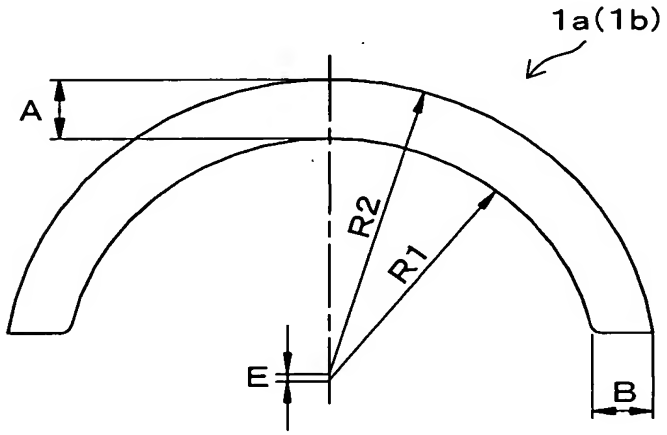


Fig. 6

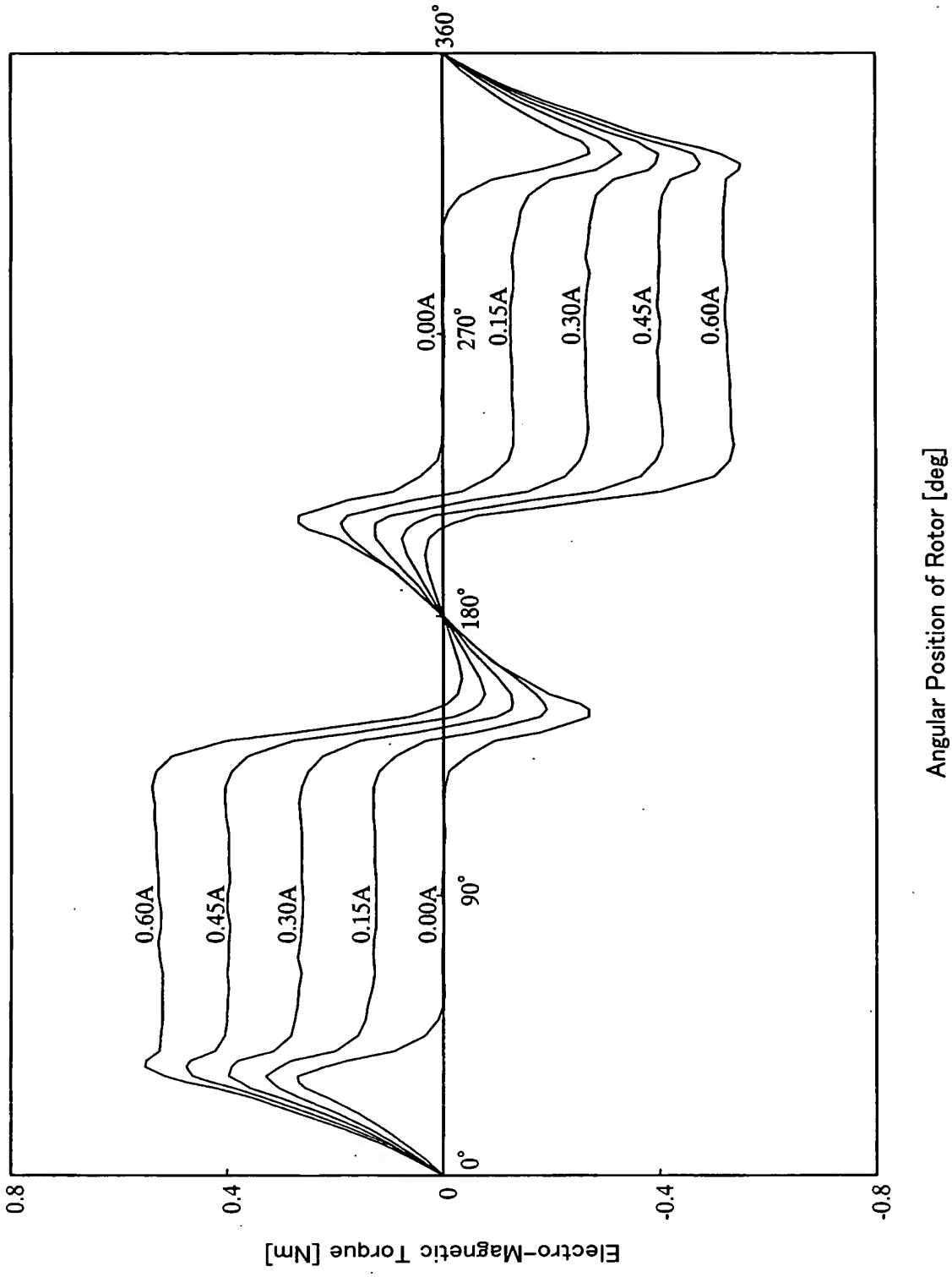

360°
270°
180°
90°
0°
0.00A
0.15A
0.30A
0.45A
0.60A
0.60A
0.45A
0.30A
0.15A
0.00A
0.8
0.4
0
-0.4
-0.8
Electro-Magnetic Torque [Nm]
Angular Position of Rotor [deg]

Fig. 7

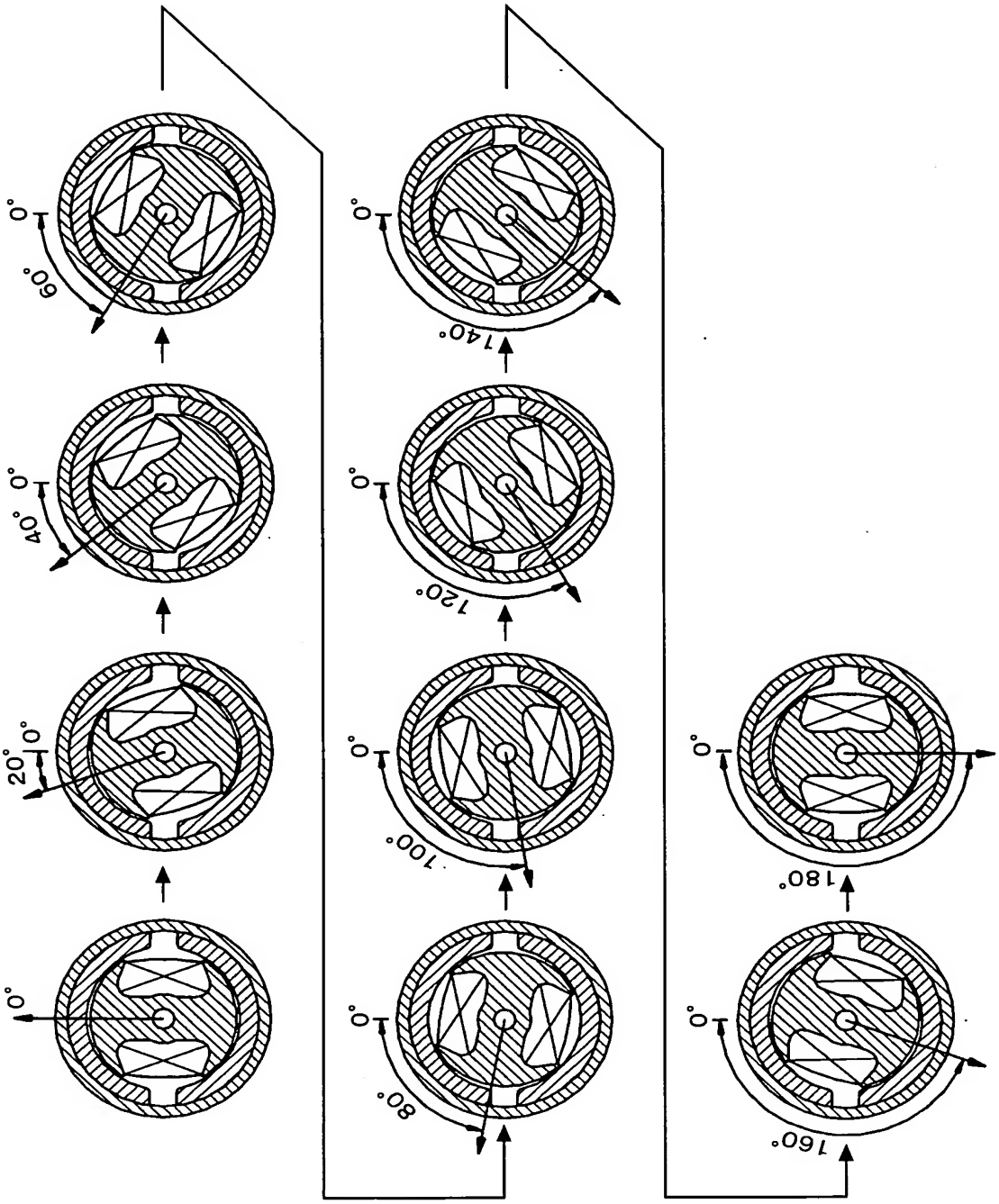


Fig. 8A

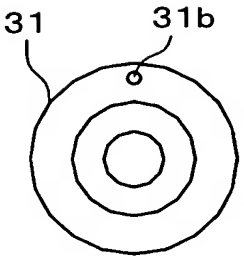


Fig. 8B

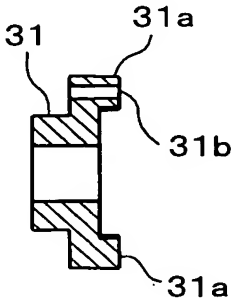


Fig. 8C

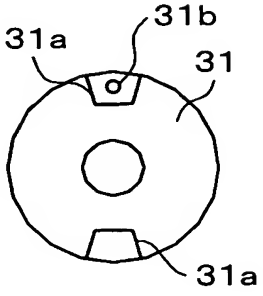


Fig. 9A

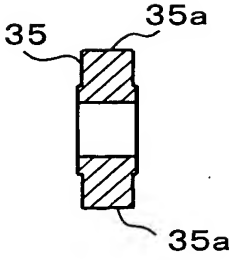


Fig. 9B

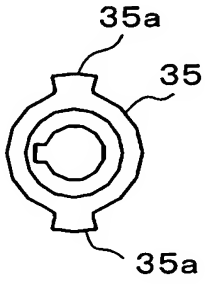


Fig. 10

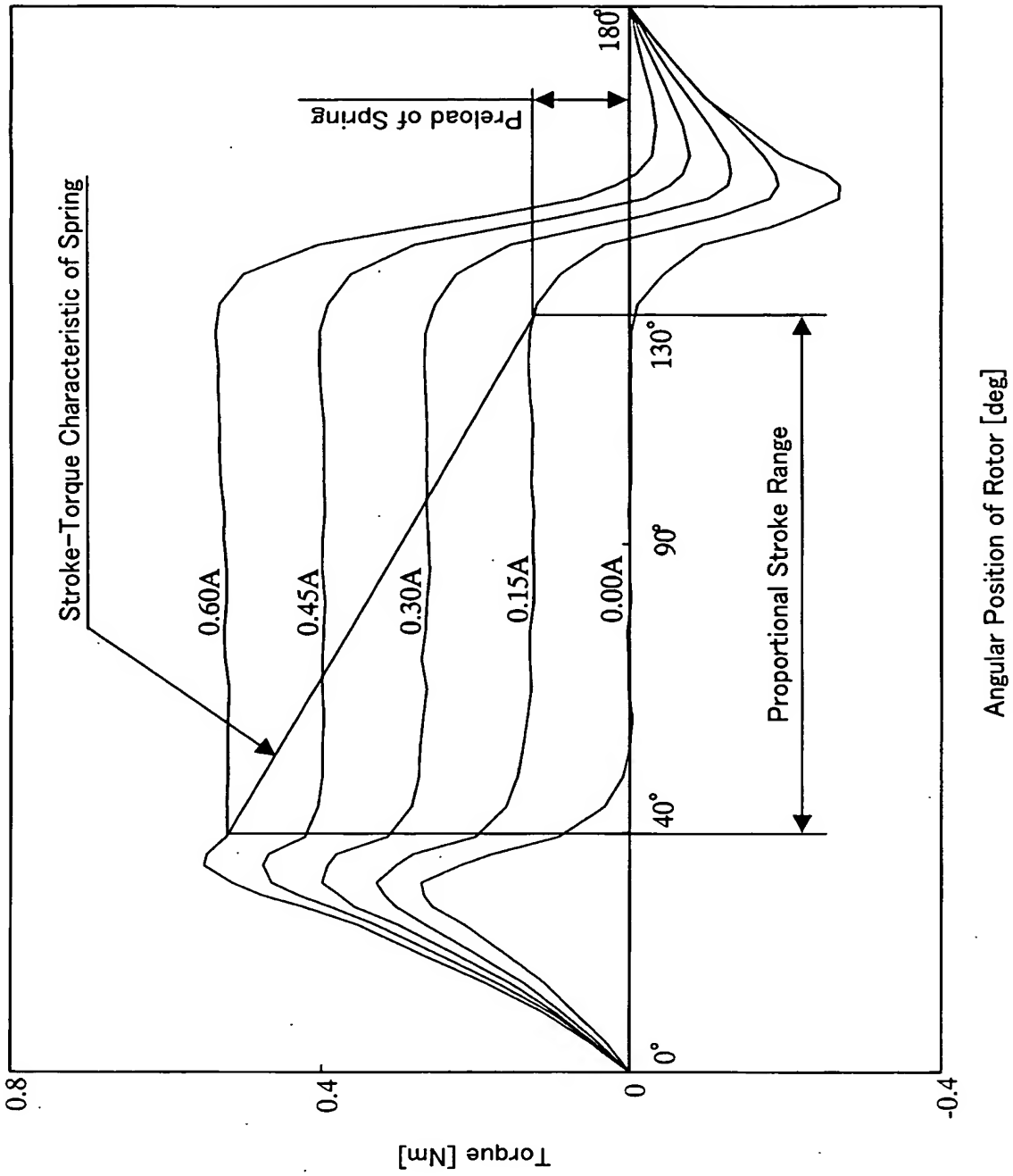

Stroke–Torque Characteristic of Spring
Preload of Spring
0.60A
0.45A
0.30A
0.15A
0.00A
180°
130°
90°
40°
0°
Proportional Stroke Range
Angular Position of Rotor [deg]
0.8
0.4
0
-0.4
Torque [Nm]

Fig. 11

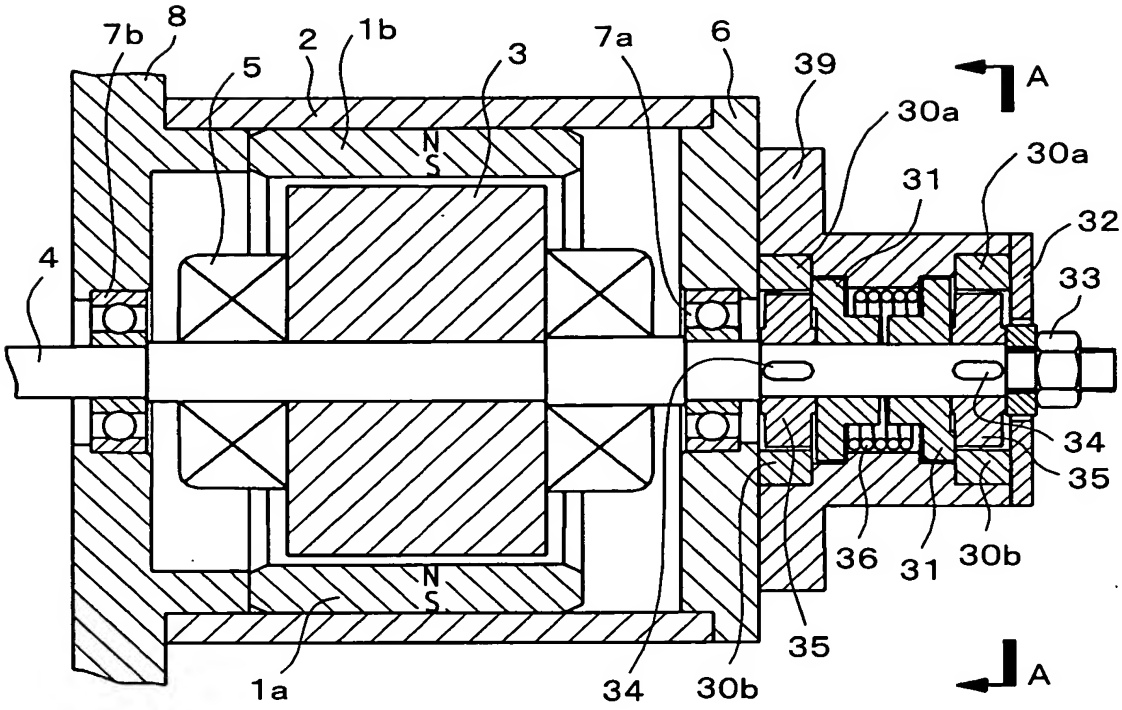

7b
8
5
2
1b
3
7a
6
39
A
30a
30a
31
32
4
33
34
35
36
31
30b
N
S
N
S
35
1a
34
30b
A

Fig. 12

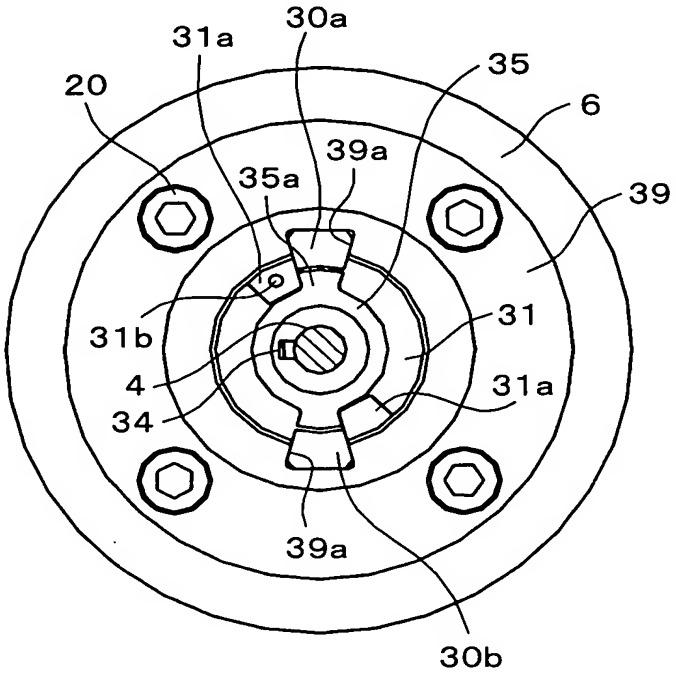

31a
30a
35
20
6
39a
35a
39
31
31b
4
31a
34
39a
30b

Fig. 13

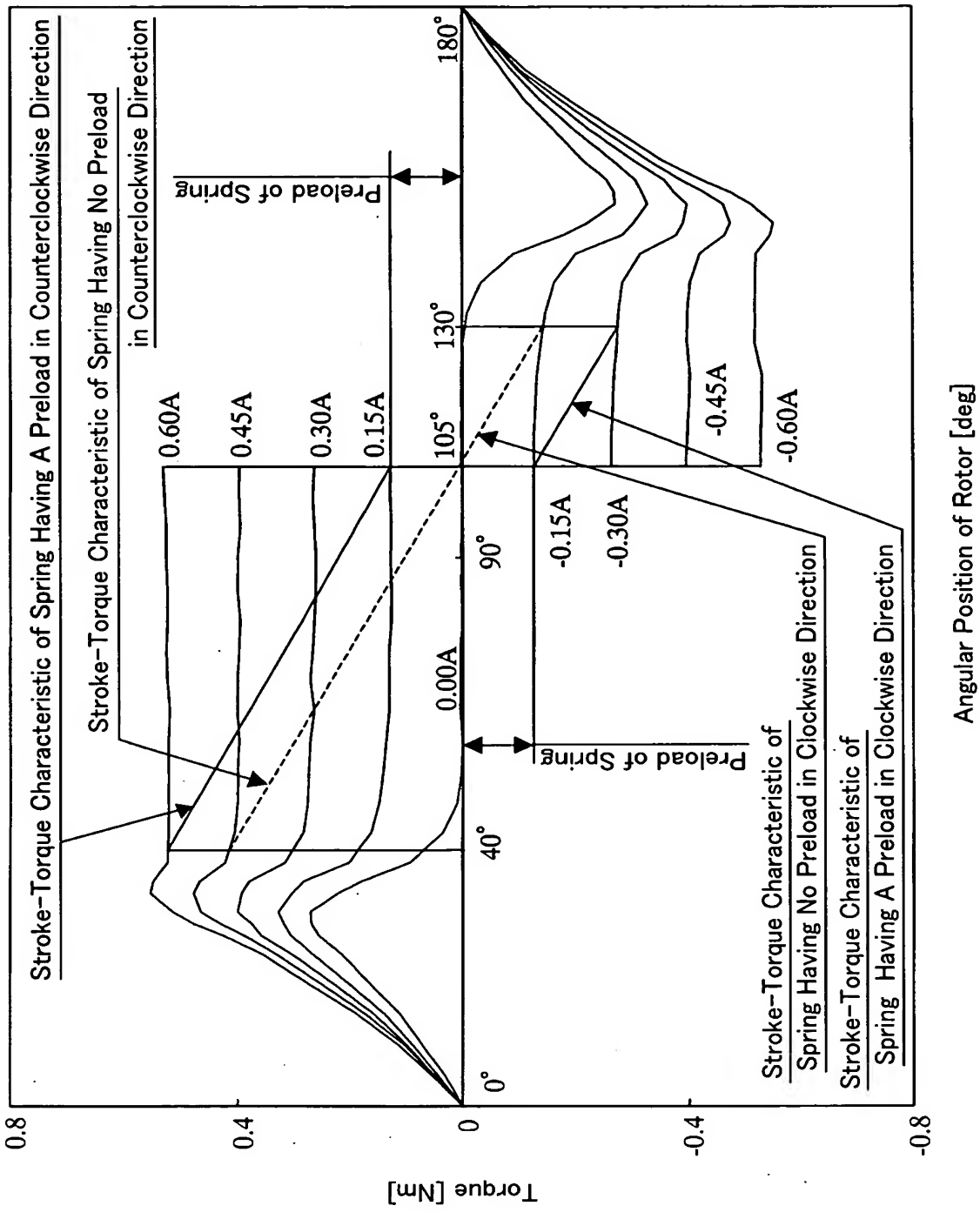

Stroke-Torque Characteristic of Spring Having A Preload in Counterclockwise Direction
Stroke-Torque Characteristic of Spring Having No Preload in Counterclockwise Direction
Preload of Spring
0.60A
0.45A
0.30A
0.15A
0.00A
-0.15A
-0.30A
-0.45A
-0.60A
180°
130°
105°
90°
40°
0°
0.8
0.4
0
-0.4
-0.8
Torque [Nm]
Angular Position of Rotor [deg]
Stroke-Torque Characteristic of Spring Having No Preload in Clockwise Direction
Stroke-Torque Characteristic of Spring Having A Preload in Clockwise Direction

Fig. 14

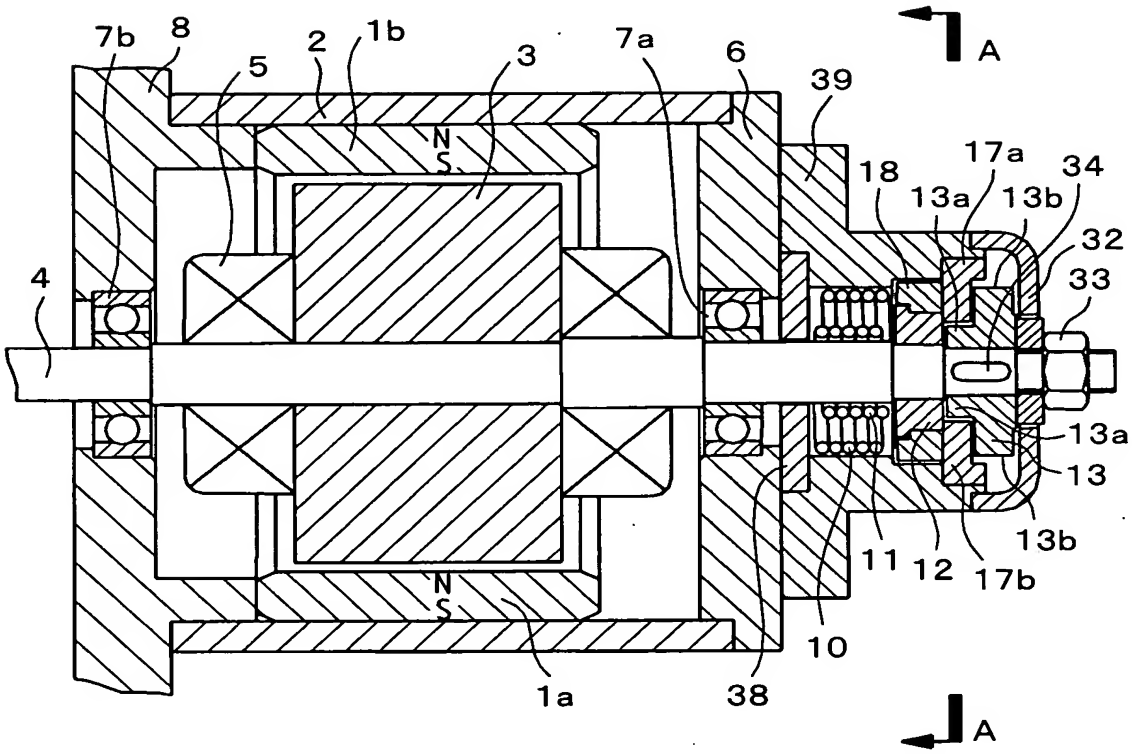

7b
8
5
2
1b
3
7a
6
39
A
N
S
18
17a
34
13a
13b
32
33
4
13a
13
13b
11
12
17b
10
1a
38
A

Fig. 15

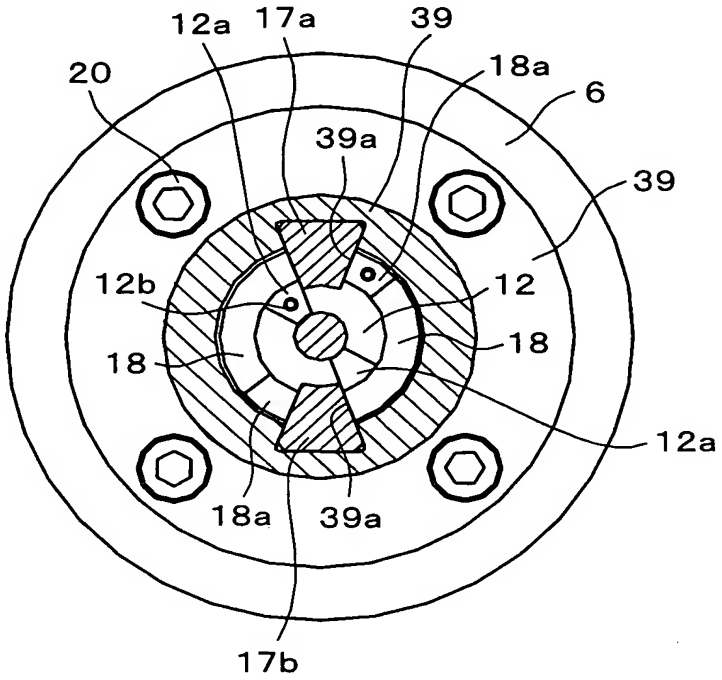

12a
17a
39
20
18a
6
39a
39
12b
12
18
18
12a
18a
39a
17b

Fig.16A

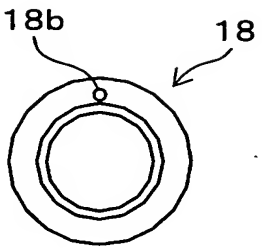


Fig.16B

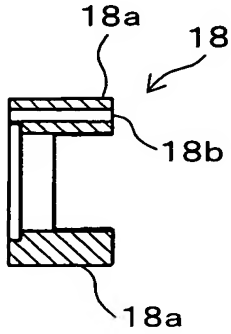


Fig.16C

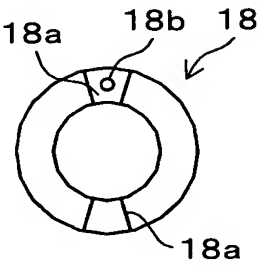


Fig.17A

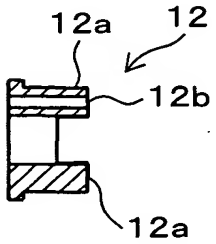


Fig.17B

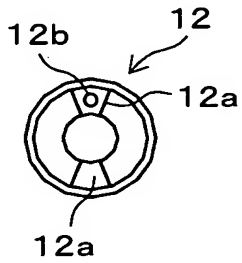


Fig.18A

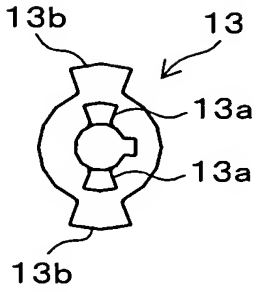


Fig.18B

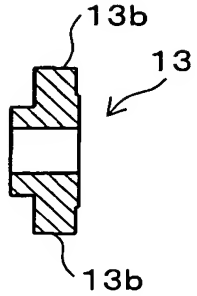


Fig.18C

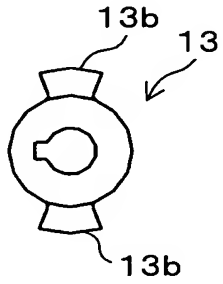
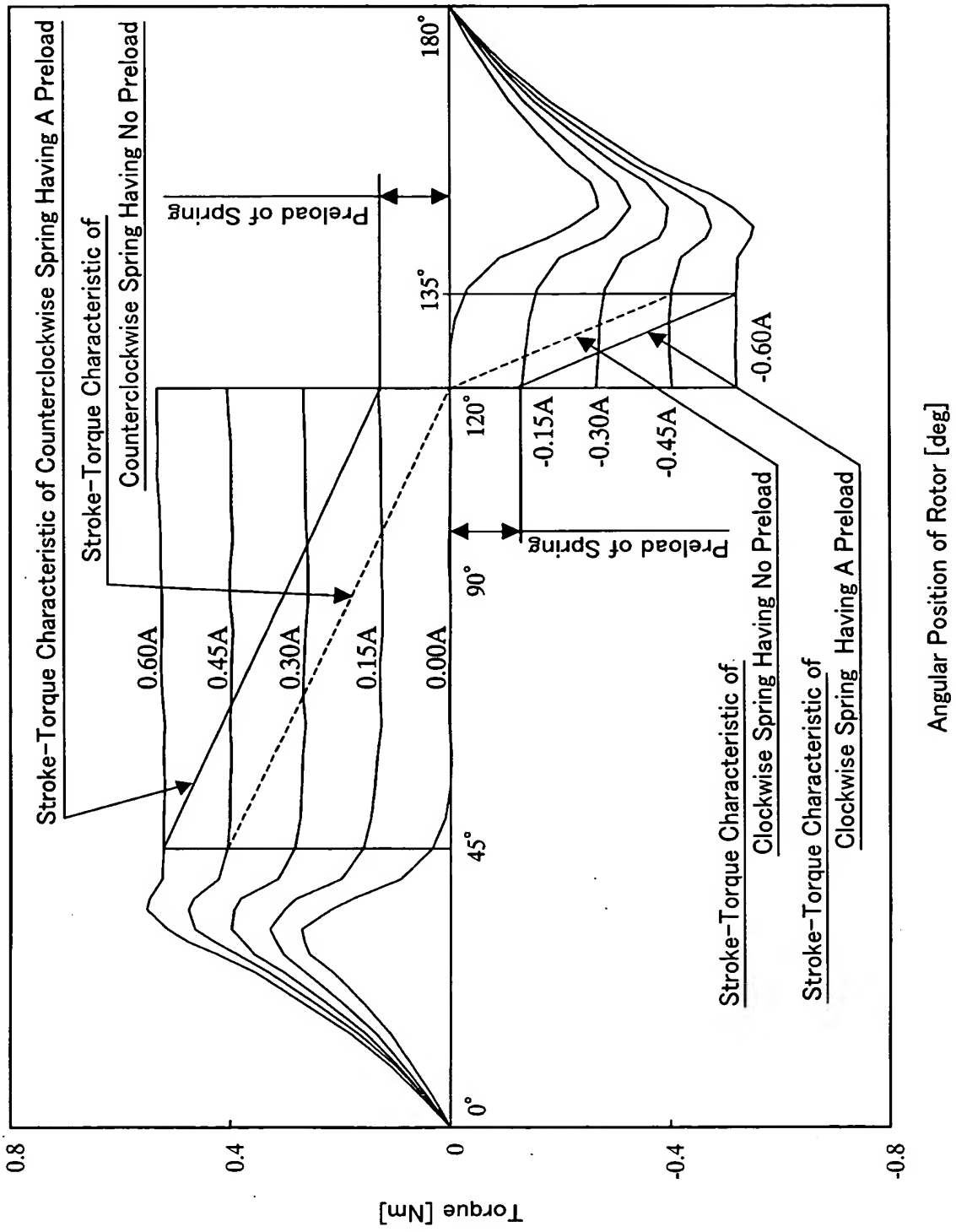


Fig. 19


Stroke-Torque Characteristic of Counterclockwise Spring Having A Preload
Stroke-Torque Characteristic of Counterclockwise Spring Having No Preload
Preload of Spring
Preload of Spring
0.60A
0.45A
0.30A
0.15A
0.00A
-0.15A
-0.30A
-0.45A
-0.60A
Stroke-Torque Characteristic of Clockwise Spring Having No Preload
Stroke-Torque Characteristic of Clockwise Spring Having A Preload
0°
45°
90°
120°
135°
180°
0.8
0.4
0
-0.4
-0.8
Torque [Nm]
Angular Position of Rotor [deg]